

REMARKS

Please consider the application in view of the above amendments and the following remarks.

I. Disposition of Claims

Claims 1-11 are pending in the application. Claims 6-11 have been withdrawn from consideration pursuant to a restriction requirement made by the Examiner in the Office Action of April 11, 2001. Claims 1 and 2 stand rejected under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 4,960,518 (the '518 patent), issued to Cadotte *et al.* In addition, claims 1-2 stand rejected under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 3,993,625 (the '625 patent), issued to Kurihara *et al.* Claims 3-5 stand rejected under 35 U.S.C. § 103 as being obvious in view of the '518 patent. Claim 1 has been amended to clarify the scope of the Applicant's invention. No new matter has been added by way of this amendment. As one example, support for amended claim 1 may be found on page 9, line 33 - page 10, line 1 of the Specification as originally filed.

II. Rejections Under 35 U.S.C. § 102

a. The '518 Patent

The Examiner rejected claims 1 and 2 under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 4,960,518 (the '518 patent). Claim 1 has been amended to recite that bromine is introduced into the polyamide skin layer by treating the polyamide skin layer with a free chlorine aqueous solution containing bromine compound. To the extent that this rejection applies to amended claim 1, the rejection is respectfully traversed.

In one aspect, the Applicant's invention relates to a reverse osmosis membrane containing bromide, wherein the bromide is applied subsequent to the formation of the polyamide skin layer. In addition, the bromide is introduced into the polyamide skin layer by treating the polyamide skin layer with a free chlorine aqueous solution containing a bromide compound. Treating the polyamide skin layer in this manner results in a structural change (namely, the incorporation of bromide) to the polyamide layer, which is observable, for example, by electron spectroscopy analysis (ESCA). *See* Specification page 9, lines 13-16.

The '518 patent discloses a composite polyamide membrane including a porous support and a thin layer of polyamide. The '518 patent further discloses that the composite polyamide membrane is treated with a specific oxidizing agent so that salt passage through the membrane is prevented from increasing under acidic conditions and that the water flux of the membrane is reduced only by 50% or less. The specific oxidizing agents disclosed in the '518 patent include peracetic acid, periodic acid, N-chloramine, and N-bromoamine. Peracetic acid and periodic acid are well known to be highly effective oxidizing agents. However, neither N-chloroamine nor N-bromoamine work as oxidizing agents because N-chloroamine and N-bromoamine decompose in an aqueous solution, as follows:



In contrast, the Applicant's invention is directed to a composite reverse osmosis membrane including a polyamide skin layer *containing bromine*. The Applicant's invention, as amended claim 1 recites, is characterized in that the polyamide skin layer containing bromine is formed by treating the layer with a free chlorine aqueous solution containing a bromine compound. When free chlorine and a bromine compound are both present in an aqueous solution, free bromine is produced. The free bromine can easily be introduced into an aromatic ring in the polyamide skin layer. Thus, the spaces between the polymer chains of the polyamide forming the polyamide skin layer can be filled with bromine atoms, thereby providing the improved rejection rate seen by the Applicant's claimed membrane.

However, in order to obtain the improved rejection rate, it is necessary that bromine be converted into *free* bromine and that the free bromine be introduced into the aromatic ring of the polyamide. Accordingly, claim 1 has been amended to recite that free bromine is incorporated into the polyamide skin layer, which Applicant believes to be a significant structural difference between the Applicant's invention and the '518 patent.

The Examiner asserts that the '518 patent discloses treating composite polyamide membrane with N-bromoamine. However, as noted above, although N-bromoamine contains bromine, the decomposition of N-bromoamine does not produce free bromine. Accordingly, the Applicant believes that free bromine is not incorporated into the aromatic ring. As shown in the comparative examples in the Specification, when a composite polyamide membrane is treated only with free chlorine or bromine, a similar improvement in the salt rejection rate is not seen.

Therefore, amended claim 1 is patentable over the '518 patent for at least the reasons described above. Accordingly, withdrawal of the § 102 rejection of amended claim 1 is requested. Claim 2, which depends from claim 1, is likewise patentable.

b. The '625 Patent

The Examiner rejected claims 1 and 2 under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 3,993,625 (the '625 patent). Claim 1 has been amended to recite that bromine is introduced into the polyamide skin layer by treating the polyamide skin layer with a free chlorine aqueous solution containing bromine compound. To the extent that this rejection applies to amended claim 1, the rejection is respectfully traversed.

The '625 patent discloses a composite membrane having a polyamide skin on a porous support. The polyamide disclosed by the '625 patent contains an aromatic ring having a -COOH group or SO₃H group. The '625 patent discloses the addition of inorganic salts in order to increase the solubility of the polyamide in the solvent during the solution polymerization method employed by the '625 patent. Notably, the addition of inorganic salts is neither to change the structure of the polymer nor to introduce bromine into an aromatic ring as in the Applicant's invention. In fact, it is extremely difficult to introduce bromine into an aromatic ring containing -COOH or -SO₃H because these groups strongly "deactivate" aromatic groups, and thus have poor reactivity.

One of the reasons that the '625 patent employs *solution* polymerization rather than the interfacial polymerization disclosed in the Applicant's invention is the poor reactivity of these substituent groups. Interfacial polymerization is a technique in which monomers having

high reactivities are dissolved in water and in an organic solution, respectively. The water and organic solution are brought into contact with each other, which creates two distinct layers (*i.e.*, like mixing oil and water). At the interface between the organic solution and the water, a thin polymer membrane is formed having a uniform thickness, which is controlled by diffusion. See Specification pages 7-8.

Therefore, interfacial polymerization is desirable for forming composite reverse osmosis membranes which use thin polymer membranes of uniform thickness. Interfacial polymerization cannot be used in the '625 patent because of the nature of the substituents, as discussed above. Accordingly, in order for the solution polymerization disclosed in the '625 patent to proceed, inorganic salts are required in order to increase the solubility of the polymer in the solvent. However, these salts are not incorporated into the aromatic rings, because of the deactivating nature of the -COOH and SO₃H groups.

Therefore, amended claim 1 is patentable over the '625 patent for at least the reasons described above. Accordingly, withdrawal of the § 102 rejection of amended claim 1 is requested. Claim 2, which depends from claim 1, is likewise patentable.

III. Rejections Under 35 U.S.C. § 103

The Examiner rejected claims 3-5 under 35 U.S.C. § 103 as being obvious in view of U.S. Patent No. 4,960,518 (the '518 patent). Claim 1 has been amended to recite that bromine is introduced into the polyamide skin layer by treating the polyamide skin layer with a free chlorine aqueous solution containing bromine compound. Claims 3-5 depend from amended claim 1, so to the extent that this rejection still applies to claims 3-5, the rejection is respectfully traversed.

The Applicant notes that in making the § 103 rejection of claims 3-5, the Examiner asserted that "[the '518 patent] discloses the composite polyamide membrane containing bromide" As noted in the discussion of the § 102 rejection above, the Applicant respectfully disagrees with the Examiner. Specifically, although N-bromoamine contains bromine, the decomposition of N-bromoamine does not produce free bromine. Accordingly, the Applicant believes that free bromine is not incorporated into the aromatic ring. As shown in the comparative examples in the Specification, when a composite polyamide membrane is treated only with free chlorine or bromine, a similar improvement in the salt rejection rate is not seen. Therefore, the Applicant believes that the '518 patent fails to disclose a polyamide membrane *introduced into* the polyamide skin layer, as recited by amended claim 1. Because amended claim 1 has been shown to be patentable over the '518 patent, claims 3-5, which depend from claim 1, are likewise patentable. Accordingly, withdrawal of the § 103 rejection of claims 3-5 is respectfully requested.

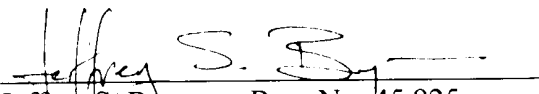
IV. Conclusion

Claims 1-5 have been shown to be allowable over the prior art. The amendments are believed to require no further prior art search. Because the amendments simplify the issues for allowance or appeal, and do not constitute new matter, entry thereof is respectfully requested. Applicant believes that the claims are allowable over the prior art and that the application is in condition for allowance. Applicant respectfully requests favorable action in the form of a Notice of Allowance.

Please apply any charges not covered, or any credits, to Deposit Account 50-0591
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Respectfully submitted,

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APPENDIX A: MARKED-UP VERSION OF THE CLAIMS

1.(Twice Amended) A composite reverse osmosis membrane comprising:

a porous support;

a polyamide skin layer formed on the porous support, wherein the polyamide skin layer is formed by reacting an aromatic compound having at least two reactive amino groups with a polyfunctional acid halide compound having at least two reactive groups[,] ; and

wherein the polyamide skin layer contains bromide introduced into the polyamide skin layer by treating the polyamide skin layer with a free chlorine aqueous solution containing a bromine compound, [wherein] the bromide being [is] introduced subsequent to forming the polyamide skin layer.